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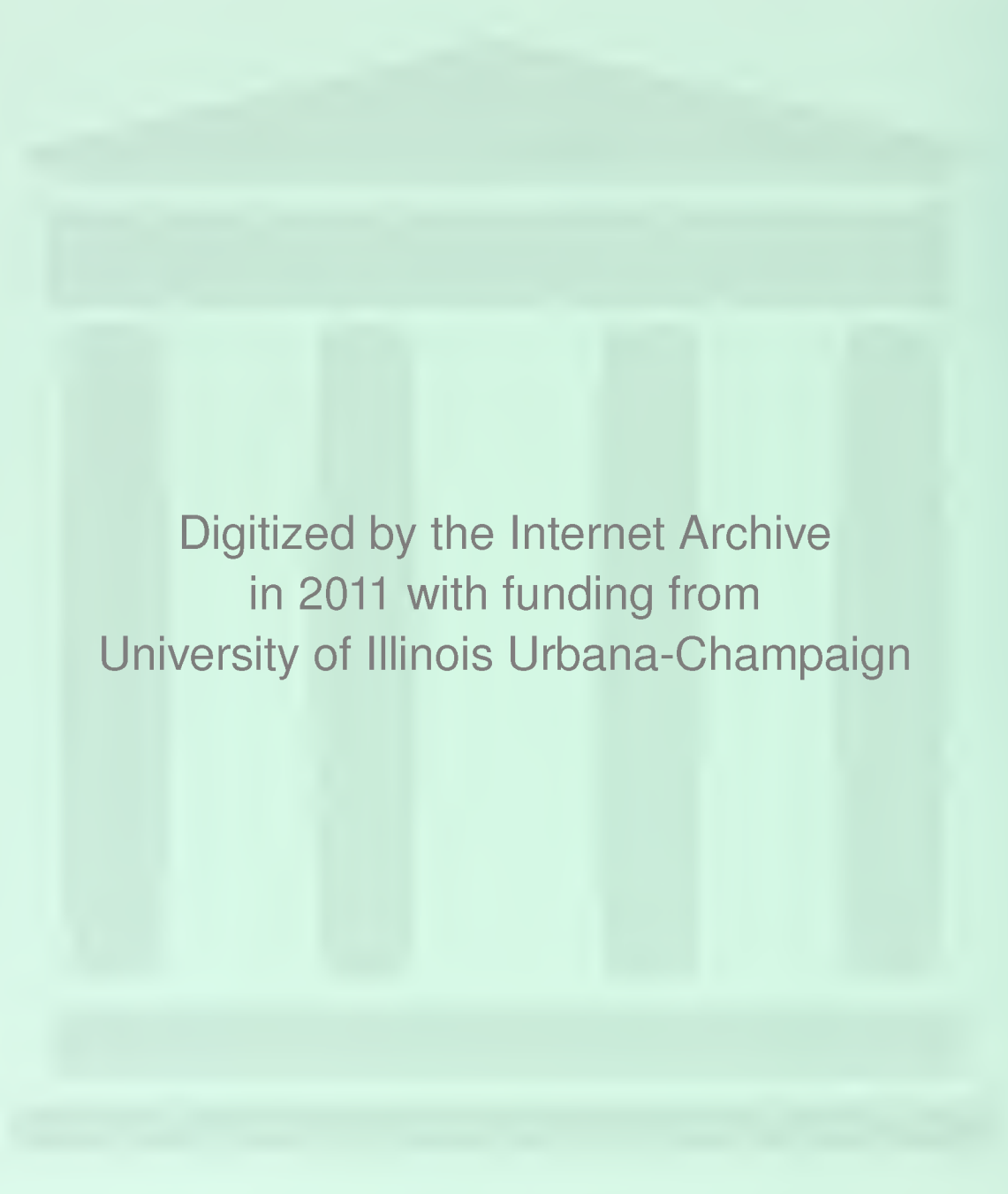
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DISCRIMINANT ANALYSIS AND THE
CLASSIFICATION OF MUTUAL FUNDS

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College of Commerce and Business Administration
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Working Paper

DISCRIMINANT ANALYSIS and the CLASSIFICATION OF MUTUAL FUNDS

During the past few years the mutual fund industry has come under increasingly harsh examination and criticism. This is due in part to the sometimes poor performance and speculative excesses that have been experienced by mutual fund investors. As a group these investors are now making their feelings known by the unprecedented level of redemptions they are inflicting upon the mutual fund industry. But, mutual funds still represent a massive accumulation of assets, \$53.4 billion¹ as of March, 1973, and may yet be the most effective means of investment for the so-called small investor.²

The selection of "successful" mutual funds from among the hundreds that are available is a difficult and uncertain process. Not only have few funds consistently outperformed the common market averages,³ but the information that most investors must rely on for fund evaluation has not been very useful.⁴ As a result, many analysts and investors have taken a simpler approach to the task of fund selection and classified supposedly similar funds into a few broad categories.

Traditional financial analysis has often relied upon stereotyped grouping as a part of its research methodology. An example of this would be the gathering of firms into industry groups in the hope of explaining some financial characteristic or pattern of business behavior. Recent studies, however, have questioned the effectiveness of these grouping procedures.⁵

The grouping of mutual funds has typically taken place around one of two features or characteristics. These are the classification by investment purpose (growth, income, stability) and the classification by type of security held (common stock, bonds). Obviously, these two classifications are not independent of one another. Most growth funds concentrate in common stocks while income funds normally have a high proportion of bonds and preferred stocks in their portfolios.

The purpose of this paper, then, is to explore the informational content or value of these classifications. Is there any real difference between growth funds and balanced funds, for instance, or is the distinction merely an advertising label that appeals to a particular segment of the investing public? Can investors rely upon traditional labels to be indicative of one fund's performance and characteristics versus funds in other categories? The problem is to discover whether there are significant differences between mutual fund classes. The approach taken in answering the question will be two-fold. First, the different characteristics, or "dimensions," of funds will be evaluated and compared individually. Then a multivariate approach, multiple discriminant analysis (MDA), emphasizing the "profile" of the funds will be applied to see if the univariate results are confirmed.

Fund Selection

The funds selected for inclusion in the study were taken from a group of 167 funds used in a previous study evaluating rates of return.⁶

This number was reduced to 90 by requiring that portfolio turnover data be available for at least three of the four years ending in 1971. Included in the group were 60 "growth" funds, 17 "income" funds, and 13 "balanced" funds. For each of these funds the following information was collected:

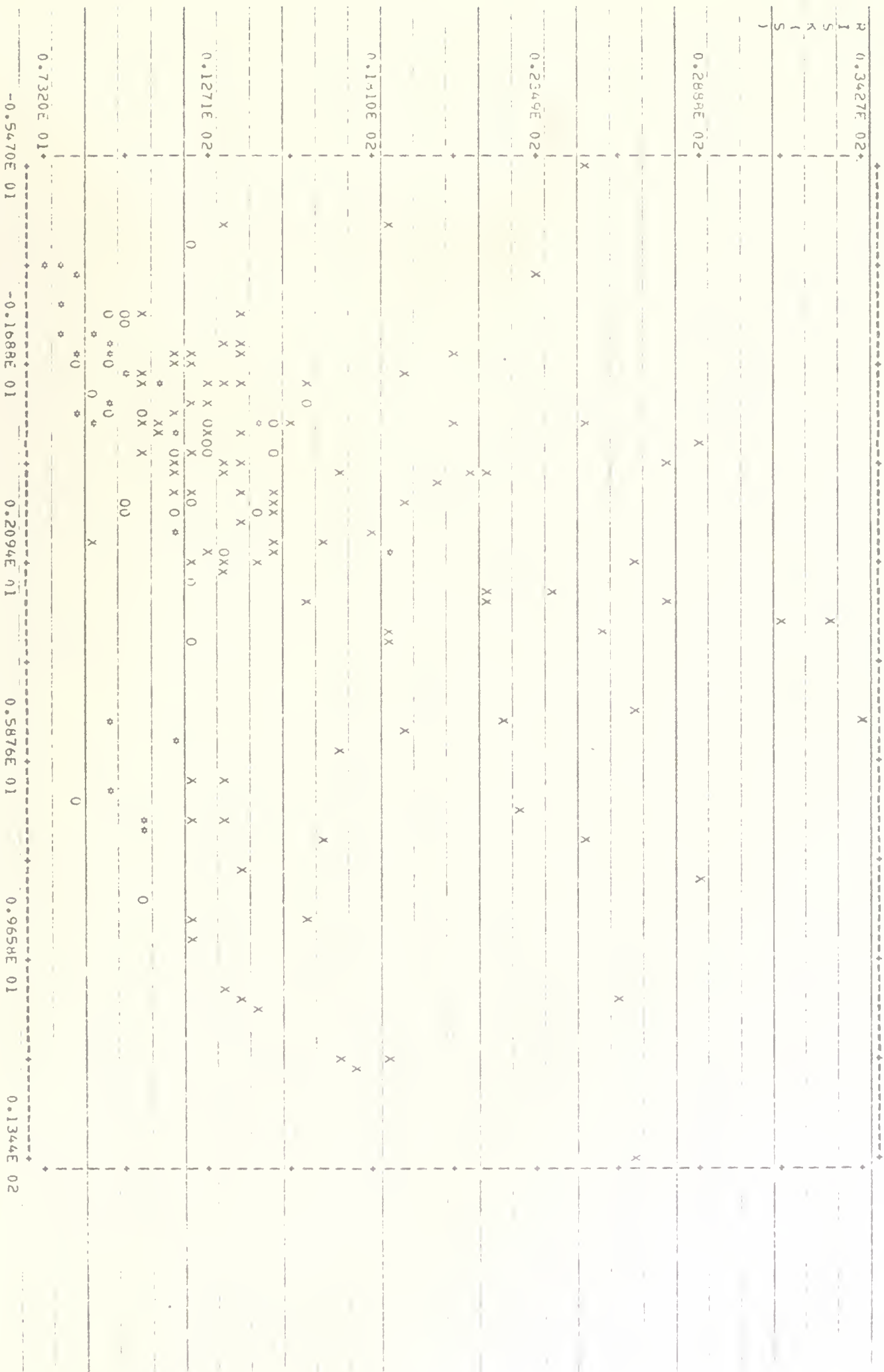
- V_1 = compound annual rate of return, 1960-1971.
- V_2 = standard deviation of return, 1960-1971.
- V_3 = fund size, millions of dollars, year end 1971.
- V_4 = average portfolio turnover rate, 1968-1971.
- V_5 = standard deviation of average portfolio turnover, 1968-1971.

Univariate Analysis

The first stage of the analysis relied upon the standard T-test to determine whether there were significant differences between the means of any single variable for two of the three groups. Only five of the fifteen univariate comparisons were significant at the .05 level of confidence. The tests failed to show substantial differences between the groups for variables V_1 , mean return, and V_3 , fund size. There were significant differences between the growth funds and the other two categories in regard to variables V_2 , variability of return, and V_4 , portfolio turnover. There was also a significant difference between growth and income funds as far as standard deviation of portfolio turnover was concerned.

FIGURE 1

R-R PLOT OF BALANCED(*), INCOME(0), AND GROWTH(X) FUNDS, (1960-1971)



MEAN RETURN

In general, the T-test analysis was not conclusive in establishing material differences among the various categories of mutual funds. Those results that were significant, however, would tend to confirm our general beliefs that "growth" funds tend to have more unstable performance than other fund groups, and that they also have a higher degree of portfolio turnover than either income or balanced funds.

Two-dimensional plotting of the mean return and standard deviation of return for the three groups individually results in risk-premium curves that are positively sloped. However, plotting all three groups together based on their eleven year (1960-1971) risk-return values does not clearly indicate distinctive fund groupings. (See Figure 1.)

Multivariate Analysis

While the examination of individual variables produced mixed results in evaluating the differences among fund categories, additional information can be gained by analyzing those same variables as a group. The technique used in this evaluation is multiple discriminant analysis (MDA). While this type of statistical examination has long been used in the area of psychology, its application in the financial and business area is much more recent.

Multiple discriminant analysis has to do with classifying an object, in this case a particular mutual fund, into exactly one of several mutually exclusive groups based on certain of its properties or characteristics. If there is some a priori classification of objects

into groups, then MDA attempts to find the linear combination of various measurements which "best" discriminates between the groups. The primary advantage of MDA is the evaluation of an entire "profile" of the mutual fund rather than sequentially examining the individual characteristics as we did with the T-test.⁷

In simplest terms, suppose we have k populations and p measures. We want to test the hypothesis that our groups are significantly different on the entire set of variables. This one-way multivariate analysis of variance hypothesis is tested by MDA. MDA locates the dimensions (discriminant functions along which the group differences are a maximum. It finds the independent linear functions of the variables which maximally discriminate between the populations. Also, by looking at the coefficients of the functions, we can determine to what extent each of the p variates contributes to each function. The discriminant functions may then be used to determine the probability that any subject belongs in any group. The results of the multiple discriminant analysis of our three fund groups is shown in Table 1. An examination of Table 1 indicates that variables V_2 - standard deviation of return, V_3 - fund size, and V_4 - average portfolio turnover rate, are the most important variables.

The measure of significance calculated for this analysis is a Wilks' lambda (likelihood ratio test statistic).⁸ This is a test of the discriminating power of the test battery. It tests the hypothesis that the population centroids (mean vectors) are equal for the k groups. For this particular analysis the Wilks' lambda was 0.706.

TABLE 1
SCALED COEFFICIENTS FOR THE DISCRIMINANT FUNCTIONS

Variable	Discriminant Function			
	One		Two	
	<u>Scaled Coefficient</u>	<u>Rank</u>	<u>Scaled Coefficient</u>	<u>Rank</u>
V ₁	-14.8	4	-17.5	5
V ₂	-35.6	1	24.5	4
V ₃	-24.2	3	-48.3	2
V ₄	-31.6	2	26.4	3
V ₅	-13.9	5	-58.1	1

Wilks' lambda = 0.706

Rao's F-Ratio Approximation:

$F_1=10$; $F_2=166$; F-Ratio = 3.15*

* Significant at the .01 level.

TABLE 2
CLASSIFICATION OF MUTUAL FUND SAMPLE

<u>Actual Category</u>	<u>Predicted Category</u>		
	<u>Growth</u>	<u>Income</u>	<u>Balanced</u>
Growth	50	10	0
Income	4	13	0
Balanced	5	6	2

The significance of this measure may be tested using a common F-test. Considering the appropriate degrees of freedom, the F-ratio of this analysis is more than significant at the .01 level of confidence.

As noted above, the discriminant functions can be used to estimate the likelihood of group membership for each of the funds involved in the analysis. The method of classification is based on the premise that a group is totally described by its mean (or centroid) and dispersion; the individual's relation to each group is determined by a X^2 which indicates how many members of the group are farther from the centroid than he, and a Bayesian probability of membership in the group based on this X^2 . The decision rule used in this particular analysis was to assign the fund to the category having the highest probability.

Overall, the results of the MDA and classification analysis were successful (see Table 2). Sixty-five of the original 90 funds were assigned to their proper categories. This included 50 of the 60 growth funds, 13 of 17 income funds, but only 2 of 13 balanced funds. No explanation is apparent for the substantially poorer performance in classifying balanced funds.

Conclusions

This research leads to conclusions in two areas, one dealing with the subject matter of the research and the second concerning the methodology applied in the analysis. The results of the multiple discriminant analysis demonstrate that there is a significant informational

content to the common labels of growth, income and balanced that are applied to broad categories of mutual funds. The fact that we were able to successfully classify more than 70% of the 30 funds studied into their appropriate category should indicate that real and measurable differences do exist. Investors, then, can make use of these classifications in determining a strategy consistent with their own investment objectives. While they may still have a difficult time in choosing individual funds from within each of the groups, the selection of one group from among all possible groups appears to be a manageable problem with a definite payoff.

Secondly, the use of a multivariate rather than a univariate approach was clearly successful in distinguishing among the three fund categories. Where the results of our T-test analysis were somewhat inconclusive, the MDA was able to do an outstanding job of differentiating the groups by examining the multi-dimensional aspects or characteristics of these funds. It appears that MDA should be an increasingly useful tool in business and financial research where few problems are encountered that do not have several significant aspects.

Footnotes

¹Investment Company Institute, Monthly Statistical Analysis, March, 1973.

²Haim Levy and Marshall Sarnat, "Investment Performance in an Imperfect Securities Market and the Case for Mutual Funds," Financial Analysts Journal, Vol. 28, No. 2 (March-April, 1972).

³J. Peter Williamson, "Measurement and Forecasting of Mutual Fund Performance: Choosing an Investment Strategy," Financial Analysts Journal, Vol. 28, No. 6 (November-December, 1972).

⁴Irwin Friend, Marshall Blume, and Jean Crockett, Mutual Funds and Other Institutional Investors: A New Perspective, (New York: McGraw-Hill, 1970).

⁵N. Gonedes, "Test of the Equivalent-Risk Class Hypothesis," Journal of Financial and Quantitative Analysis, June, 1969; also, Donald L. Stevens, "Multivariate Analysis, of Financial Characteristics of Acquired Firms in Industrial Mergers," (Ph.D. Dissertation, Michigan State University, 1972).

⁶Robert T. LeClair, "Rates of Return on Mutual Funds, 1960-1971," College of Commerce and Business Administration Working Paper Series #64, University of Illinois, September, 1972.

⁷One of the earliest examples of multiple discriminant analysis in the area of finance and investments was Keith V. Smith, "Classification of Investment Securities Using Multiple Discriminant Analysis," Institute Paper No. 101, Krannert Graduate School of Industrial Administration, Purdue University, Lafayette, Indiana, January, 1965.

⁸W. W. Cooley and P. R. Lohnes, Multivariate Procedures for the Behavioral Sciences, (New York: John Wiley & Sons, Inc., 1962), p. 116-150.



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